



INSTRUCTIONS

ENGINE SUPPORT SYSTEMS

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INTRODUCTION

This section covers the various engine support systems on-board the locomotive. The intent of this section is to provide an understanding of how individual items of equipment contribute to the functioning of each pertinent system. This will aid maintenance personnel in diagnosing malfunctions and determining the correct procedure to be followed to resolve problems. It also is intended to be used in conjunction with the Section IX Diesel Engine instructions to diagnose problems when they occur.

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

Verify numbers for parts, tools, or material by using the Renewal Parts or Tool Catalogs, or contact your General Electric representative for assistance. Do not order from this publication.

It should be noted that variations in the systems will exist between different models of locomotives and between railroad customers. Also, because of the complexity of the systems, liberties have been taken in the method of presentation. Some engine support systems are presented as diagrams and some as line drawings. In all cases, the diagrams and drawings are intended for the general guidance of personnel.

FUEL-OIL SYSTEM

DESCRIPTION

The engine fuel supply is contained in a fuel tank located below the locomotive platform. Fuel is drawn from the tank by the electric-driven fuel-booster pump and is circulated through the system, Fig. X-1.

The fuel system consists of the following components, listed in order of fuel flow from the fuel tank through the system:

1. Fuel tank
2. Fuel heater (optional)
3. Single-element fuel strainer
4. Fuel-booster pump
5. Relief valve
6. Primary filter
7. Engine fuel header
8. Injection equipment
9. Regulating valve
10. Fuel drain headers.

The suction side of the system is between the tank and the fuel-booster pump. Fuel is drawn through a fuel heater (optional) and through a single-element fuel strainer before reaching the pump.

FIG. X-1, E-18334D

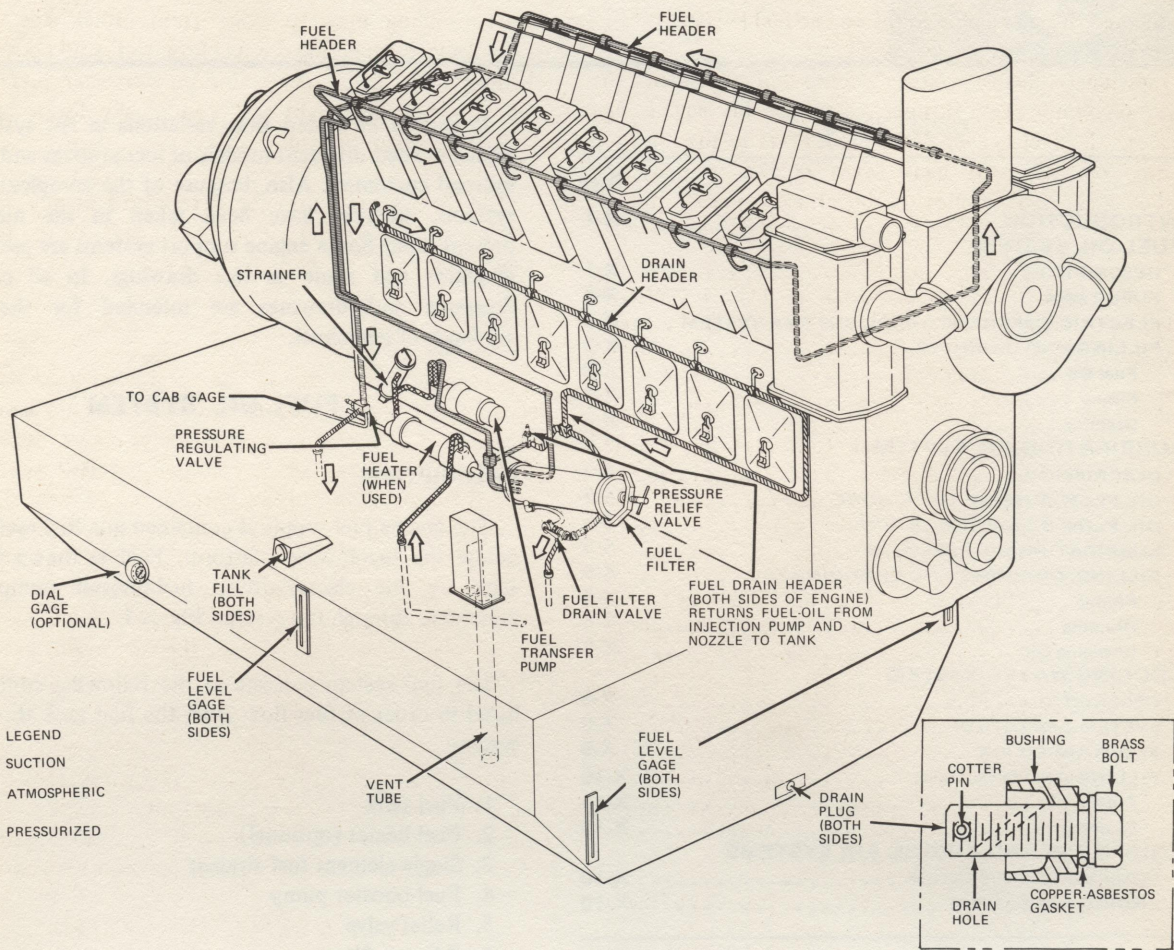


FIG. X-1. DIESEL ENGINE FUEL-OIL SYSTEM (TYPICAL).

The pressure side of the system is located between the booster pump and the pressure-regulating valve, which discharges excess fuel back to the tank. Fuel discharged by the booster pump flows to a single-element fuel filter. A relief valve is also connected to the pump discharge and protects the booster pump from overloads caused by flow restrictions in the pressure side of the system. Fuel is then conducted through a pipe to the engine fuel header.

Individual flexible hoses connected between the injection-pump inlet fittings make up the engine fuel header. The fuel header first supplies fuel to the injection pumps on the right bank, then crosses over by the turbocharger and supplies the injection pumps on the left bank.

Excess fuel returns to the tank through a regulating valve, which is adjusted to maintain pressure in the engine fuel header.

Two fuel drain headers, one on each side of the engine frame, collect fuel leaking back from the injectors and high-pressure pumps and direct it back to the fuel tank.

FUEL TANK

Units are equipped with a single fuel-supply tank, centrally located below the platform. The tank is equipped with two fill openings, one on each side of the tank. Two fuel-level sight gages, one near each fill opening, are standard equipment on the tank. Fuel-level dial gages may be applied to the tank as optional equipment. The bottom of the tank serves as a sump and is equipped with a drain plug at each end. One vent pipe vents the tank to atmosphere.

ELECTRIC EMERGENCY FUEL CUT-OFF SYSTEM

The electrically-operated, emergency fuel cut-off system is arranged with three emergency trip switches; one located on the right side just forward of No. 1 lifting lug; one on the left side just above the No. 1 end of the fuel tank; and one in the operator's cab. Momentarily depressing any one of these switches will cause the fuel-booster pump to stop, thus stopping the flow of fuel to the engine. At the same time, a signal to the governor stops the engine. Once tripped, the system is restored to normal by depressing a "reset" button in the operator's cab; or upon starting the engine, the system is reset automatically.

FILLING AND DRAINING

Fuel Oil

The fuel oil recommended for the engine is distilled fuel and should conform to the American Society for Testing

Materials (ASTM) Specification D-975 No. 2-D. For extreme low temperatures, or for engines operating at high altitudes, number 1D fuel, with a minimum cetane value of 45, may be used.

Filling

Fuel filling may be done from either side of the locomotive by applying the fuel hose to the fill opening (fill fittings may differ, depending on customer preference). Observe the upper sight gage periodically during filling to determine when the tank is full.

The fuel supply may be determined at any time by observing the upper and lower sight gages or the fuel dial gage (if used) for the indicated fuel level.

Draining

The fuel tank should be periodically drained of accumulated water condensate by the use of the drain plugs at each end of the tank sump. These plugs are made with a straight-thread screw which contains a drilled passage and has an internal stop to limit the number of turns they can be opened. If an excessive amount of water is found in the fuel tank, a check of the engine fuel filter, fuel heater (if used) system and fuel supply should be made immediately. Also check the possibility that leakage from a cylinder may be getting to the tank through the fuel return headers. If water is permitted to enter the fuel system, it can cause extensive damage to the system parts.

Large quantities of fuel may be drained quickly from the tank by removing the drain plug from each end of the tank sump. The sump end-covers may be removed to gain access to the tank when internal cleaning becomes necessary.

LUBRICATING-OIL SYSTEM

DESCRIPTION

The diesel-engine lubricating-oil system, Fig. X-2, provides pressure lubrication to bearings within the engine and carries away heat produced by friction and combustion.

The lubricating-oil system is of the full-flow type, in that all of the oil used must circulate through the lube-oil filter. There is no oil-filter bypass valve, and no provision of any kind which would permit unfiltered oil to circulate through the system should the filter become obstructed.

This system is used to prevent unfiltered oil and the harmful foreign materials it might contain from contaminating the engine and its components. A low oil

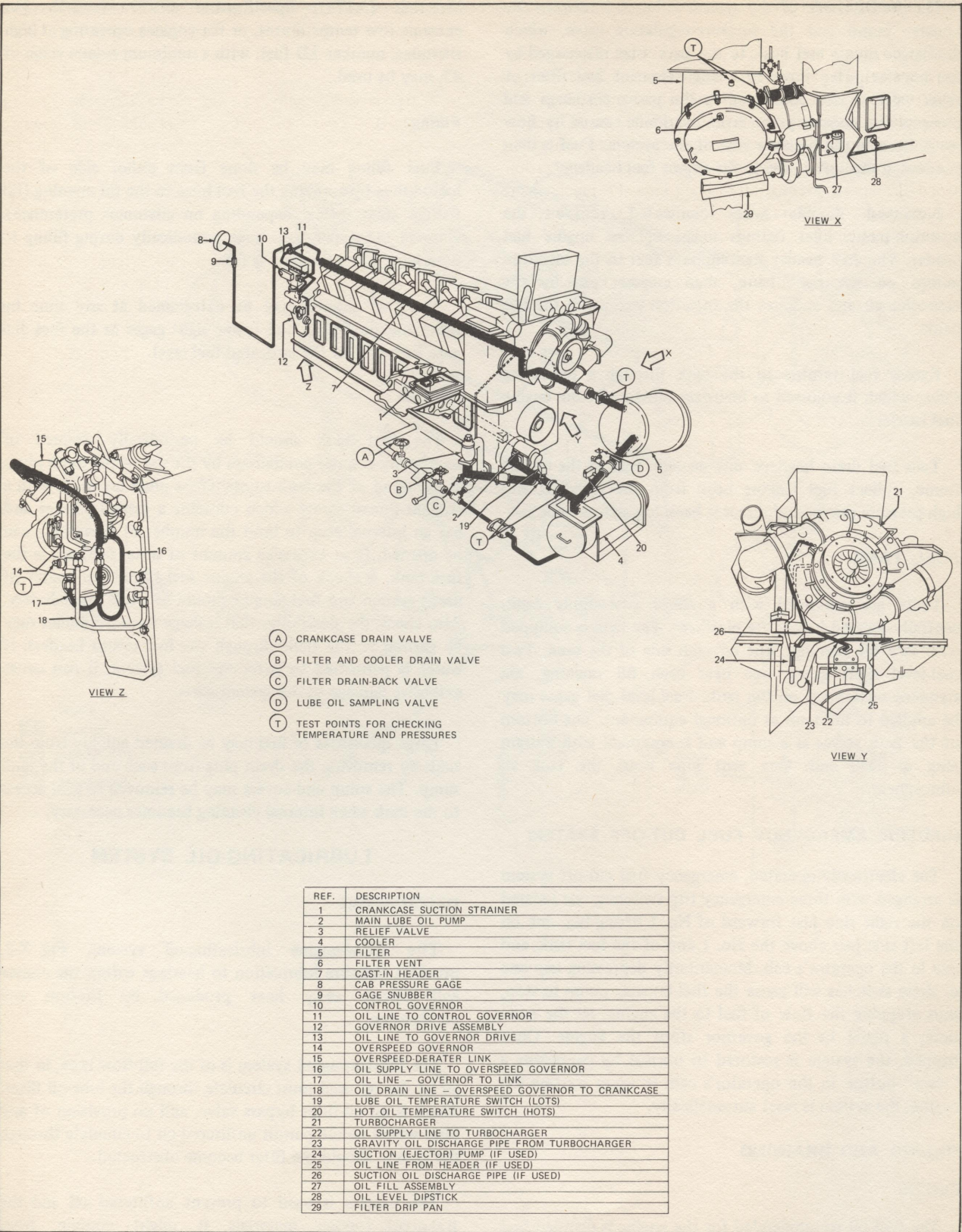


FIG. X-2. LUBRICATING-OIL SYSTEM.

FIG. X-2, E-24367

pressure device is provided in the control governor. This device samples the existing oil pressure, and should the pressure drop to a sub-normal value, it will cause the engine speed and load to go to a reduced value. If the pressure drops to a dangerously low value (approximately 4 psi), the device will cause engine shutdown.

The lubricating-oil system consists of the following components in their order of oil flow, Fig. X-2:

1. Engine crankcase
2. Pump
3. Relief valve
4. Cooler
5. Filter
6. Engine supply system.

An oil pan is bolted to the main frame to enclose the bottom of the crankcase and to hold the oil supply. An oil-fill opening is sealed by an expandable plug. A dipstick is used to measure the crankcase oil level at engine idle.

OIL FLOW OUTSIDE THE ENGINE

Oil discharged from the pump is piped to the lube-oil cooler. A relief valve protects the system against excessive pressure. The oil flows through the cooler and then to the oil filter. The water flowing down through the tubes inside the cooler removes heat from the oil. The oil is discharged from the filter and is piped to the engine forward (free) end cover.

OIL FLOW INSIDE THE ENGINE

The main engine supply header and branch passages within the main frame conduct oil to all main bearings and to four of the camshaft bearings. Oil enters the crankshaft from the main bearings and flows through angularly-drilled passages in the shaft to the crankpin bearings.

The oil passes from the crankpin up through both connecting rods to lubricate the piston pins. The oil then passes to the piston crowns. It is shaken-around in the chamber under the piston crown thereby cooling the whole piston head, and then flows out through drain holes back to the crankcase.

The oil entering the camshaft bearings is conducted lengthwise through the drilled camshafts. Holes drilled radially into the shafts supply oil to each of the other shaft bearings.

The camshaft bearings contain annular grooves connecting to drilled passages in the engine main frame. Oil flows through these passages to the valve and fuel push rod crossheads.

The oil then flows upward through the valve push rods to supply lubrication to the valve operating parts at the top of the cylinder. Oil return is through the valve push rod cavities to lubricate the cams and cam rollers, and then to the crankcase.

The forward-end cover bearing and the idler gear bushings are lubricated through a passage from the oil header to an annular groove around the cover bearing. Another drilled passage connects the annular bearing groove to a drilled passage in the idler gear shaft. The auxiliary drive gear, located on the crankshaft next to the vibration damper, is lubricated internally by oil flowing through a passage within the shaft and through the gear hub. Oil from these bearings returns by gravity to the crankcase.

The turbocharger bearings receive lubrication through an external line, flange-connected to the oil header at the forward-end cover. From the turbocharger, the oil is returned to the crankcase through a pipe that is also flange-connected to the cover.

Lubricating oil is piped to the governor drive assembly through a pipe that is flange-connected to the engine oil header at the generator end. The oil from the governor drive returns to the crankcase internally.

The oil supply for the overspeed governor is maintained in a small reservoir built into the governor drive gear case. The reservoir is kept filled with oil by a drilled passage in the gear case.

The camshaft gears are splash-lubricated through an orifice and pipe from the engine oil header.

The bearings and drive gears of the oil and water pumps are lubricated by running partially submerged in lube oil contained within the forward-end cover reservoir.

LUBRICATING-OIL PRESSURE

Oil pressure must be maintained at all times during engine operation. Insufficient oil pressure will cause extensive damage to the bearings, pistons, cylinders and other moving parts within the engine.

The low lube-oil pressure device will stop the engine and turn on a yellow indicating light in the operator's cab if a condition of insufficient oil pressure exists.

During engine starting, a time delay built into the low oil-pressure shutdown device allows time for the engine oil pressure to build up. If the pressure fails to build up within the time allowed, the low oil-pressure device will trip and prevent the engine from starting.

FILLING, DRAINING AND CHANGING OIL**Filling**

To service the lubricating-oil system, proceed as follows:

1. Check that drain Valves A, B and C are closed, Fig. X-2.
2. Fill the crankcase, through the oil fill pipe or through a crankcase inspection opening, with the correct quantity of new lubricating oil. The oil must conform to the required specifications. Fill the crankcase to the FULL level mark on the dipstick.
3. With the engine idling, the oil level must be between the FULL and LOW marks on the dipstick.

Regardless of time or mileage, the lube oil should be changed whenever contamination with water or fuel oil reaches or closely approaches the condemning limits given in the lubrication and servicing instructions. It should also be changed when it is contaminated with fine metal particles. Such contamination can result from scoring of pistons, piston rings, liners, crossheads or guides; failure of gears or bearings; and any other similarly worn or failing parts.

Draining

The lubricating-oil system is drained by the use of three valves which are identified as Valve A, Valve B and Valve C, Fig. X-2. The following list identifies the valve, or combinations of valves, which must be opened to drain the various portions of the system.

1. Valve A (the crankcase drain valve) is opened to drain the main oil supply from the engine crankcase.
2. Valve B (the end-cover drain valve) drains the oil filter and oil cooler overboard.
3. Valve C (the filter drain-back valve) drains the oil filter and oil cooler back to the crankcase.
4. With Valves B and C both open, the oil filter, oil cooler and front end drain overboard.

Changing Oil

1. With the engine stopped, remove the pipe cap from the drain pipe. The pipe extends below the platform over the fuel tank on the right side of the engine.
2. Arrange barrels or a drain-hose system to catch the used oil.

3. Open the crankcase drain Valve A, end cover drain Valve B, and filter drain-back Valve C.
4. Remove the vent plug on the filter cover.
5. When the old oil is completely drained, close Valves A, B and C. Replace the vent plug in the filter cover and reapply the cap to the drain pipe.

COOLING WATER SYSTEM**DESCRIPTION**

The locomotive cooling water system, Figs. X-3 and X-4, maintains an essentially constant engine operating temperature throughout its load range and with wide variations in ambient temperature. Fig. X-3 shows a simplified version of Fig. X-4.

Considerable heat is generated as a result of fuel combustion in the diesel engine, friction caused by moving parts in the engine and air compressor, compression of the intake air by the turbocharger and compression of air by the air compressor. Unless this heat is removed at the same rate it is generated, the heat would soon destroy gaskets, seals, hoses, etc. and would ultimately destroy the engine and air compressor.

Most of the generated heat is transferred from the metal masses directly to the coolant; about 20 percent of the engine heat is transferred first to the lube oil and then, thru the lube-oil cooler, to the coolant. Heat then is transferred from the coolant to the atmosphere thru the radiator sections. When equipped, the warm coolant heats the fuel oil thru a fuel-oil heater.

A pressurized, dry-radiator type system is employed. The rate of transfer of heat from the coolant to the atmosphere is dependent on atmospheric temperature and pressure, and the heat rejection from the engine is controlled by a fluid-amplifier flow-control valve in the system.

The principal components in the system are:

1. Water storage tank
2. Lube-oil cooler
3. Water pump
4. Water inlet headers
5. Water outlet header
6. Cylinders
7. Intercoolers
8. Turbocharger
9. Fluid-amplifier flow-control valve
10. Radiator sections
11. Air compressor
12. Fuel-oil heater (optional)
13. Valves, switches and interconnecting piping.

FIG. X-3, E-19651

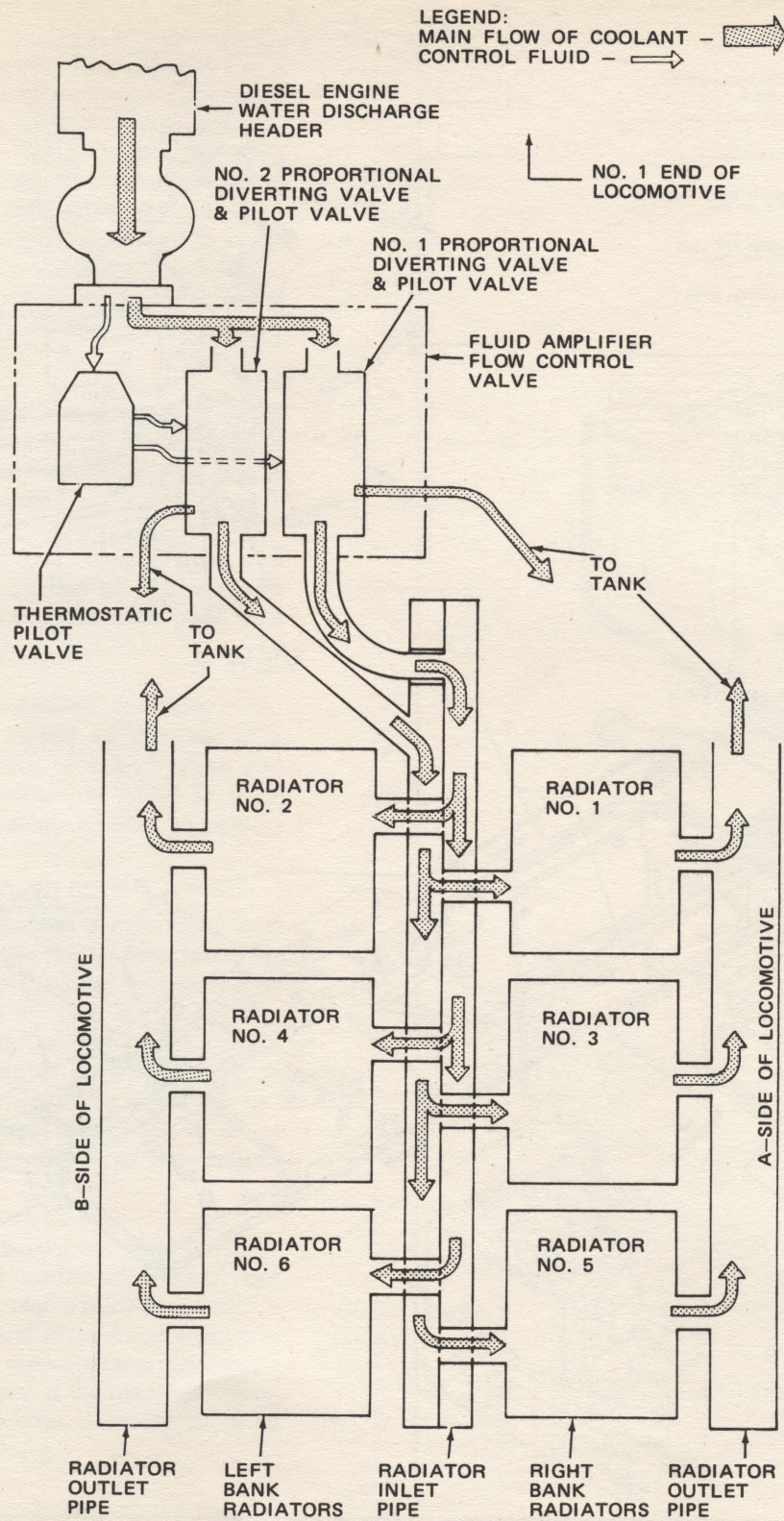


FIG. X-3. WATER FLOW, DIAGRAMMATIC VIEW.

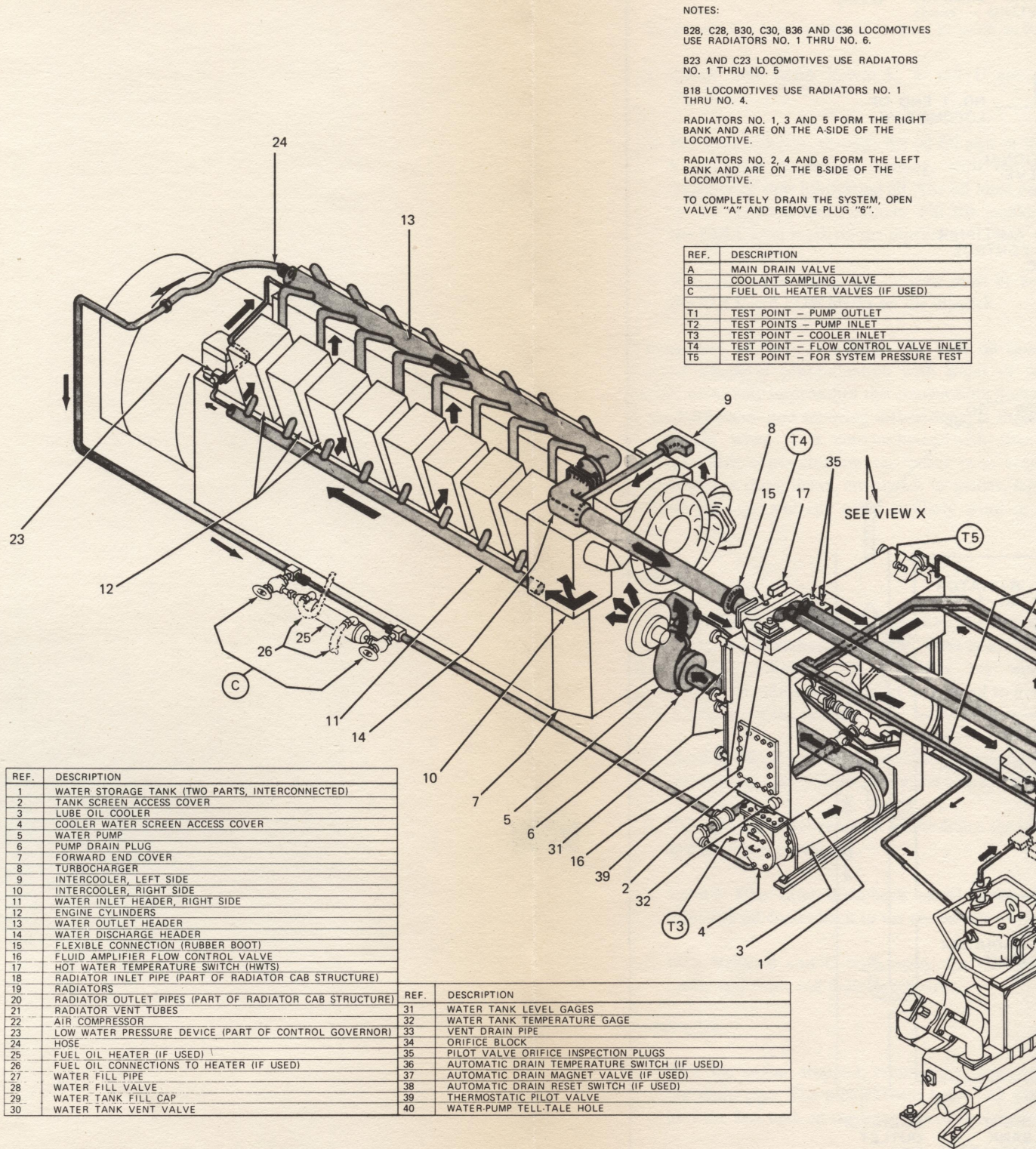


FIG. X-4. COOLING WATER SYSTEM.

B28, C28, B30, C30, B36 AND C36 LOCOMOTIVES
USE RADIATORS NO. 1 THRU NO. 6.

B23 AND C23 LOCOMOTIVES USE RADIATORS
NO. 1 THRU NO. 5

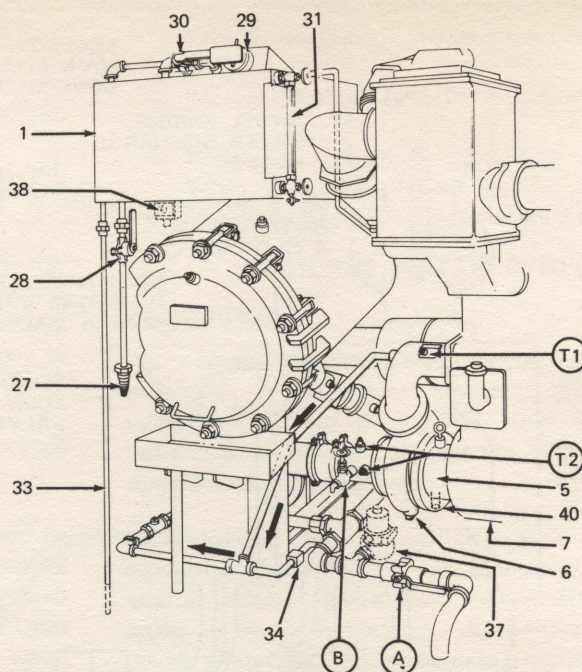
B18 LOCOMOTIVES USE RADIATORS NO. 1
THRU NO. 4.

RADIATORS NO. 1, 3 AND 5 FORM THE RIGHT BANK AND ARE ON THE A-SIDE OF THE LOCOMOTIVE.

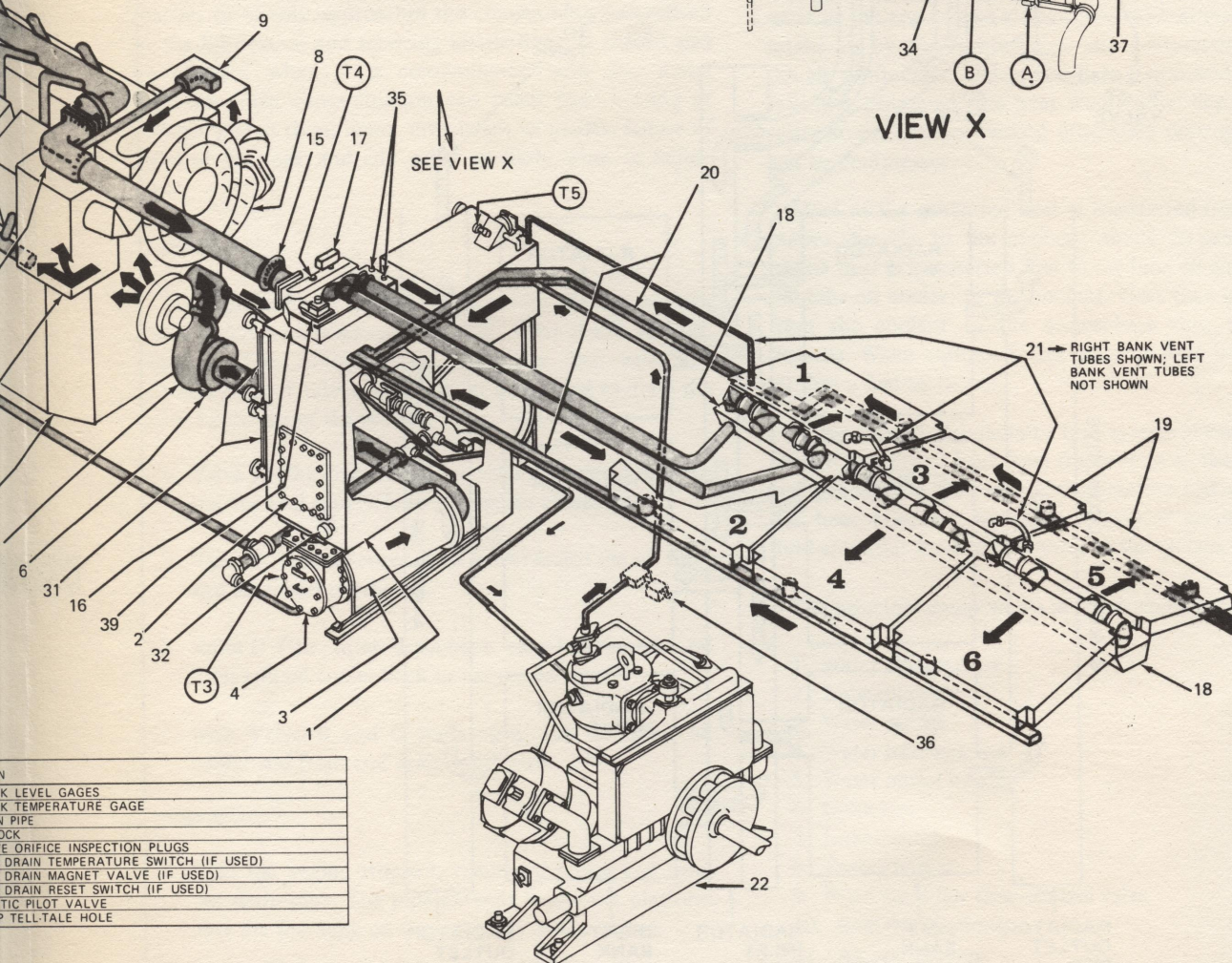
RADIATORS NO. 2, 4 AND 6 FORM THE LEFT BANK AND ARE ON THE B-SIDE OF THE LOCOMOTIVE.

TO COMPLETELY DRAIN THE SYSTEM, OPEN VALVE "A" AND REMOVE PLUG "6".

REF.	DESCRIPTION
A	MAIN DRAIN VALVE
B	COOLANT SAMPLING VALVE
C	FUEL OIL HEATER VALVES (IF USED)
T1	TEST POINT – PUMP OUTLET
T2	TEST POINTS – PUMP INLET
T3	TEST POINT – COOLER INLET
T4	TEST POINT – FLOW CONTROL VALVE INLET
T5	TEST POINT – FOR SYSTEM PRESSURE TEST



VIEW X



N
K LEVEL GAGES
K TEMPERATURE GAGE
N PIPE
OCK
E ORIFICE INSPECTION PLUGS
DRAIN TEMPERATURE SWITCH (IF USED)
DRAIN MAGNET VALVE (IF USED)
DRAIN RESET SWITCH (IF USED)
TIC PILOT VALVE
P TELL-TALE HOLE

FIG. X-4, E-24366

SYSTEM OPERATION

The cooling water system is a pressurized, dry-radiator type system. The system, when in operation, must be tight and free of all leakage so pressure can be maintained. The dry-radiator system is one having no coolant in the radiator sections when the engine is shut down and when the coolant temperature is in the lower range of operation; when the coolant temperature goes into the medium and higher ranges of operation, coolant is diverted into the radiator sections for cool-down. This feature is mandatory when the ambient temperature is subfreezing, since the radiator sections are outside the zone of heat generated by the diesel engine.

Water leaving the storage tank is drawn downward through vertical tubes in the lubricating-oil cooler and is then piped to the suction side of the engine-driven centrifugal water pump.

Water discharged from the pump enters a lateral passage in the forward-end cover of the engine, where it is distributed to the water inlet header pipes, the turbocharger and the intercoolers.

The water inlet headers; one along each side of the engine, distribute cooling water to the cylinders. These headers are comprised of sections which are individually removable. Each section is bolted to its cylinder and connected to adjacent sections by compression pipe couplings.

Each cylinder contains a liner whose outer surface is machined to form two annular water bands. Water from the water inlet headers, coming through the jacket wall, is distributed around the liner by the lower waterband. It then passes through the 1/8-in. annular space, formed by the distribution dam on the outside diameter of the liner and the inside diameter of the jacket, into the upper water band. From the upper water band, it continues into the head through a large number of holes drilled in the upper liner wall.

The engine intercoolers, which remove heat from combustion air, are constructed with a fabricated-steel case enclosing a fin and tube-type radiator core. Cooling water, from the forward-end cover, enters at the bottom of each intercooler, passes vertically three times through the core, and then is discharged at the top of the cooler. Water flow through each intercooler is limited by an orifice in the cooler discharge opening.

The turbocharger, located at the forward-end of the engine, receives its cooling water through two openings in the top surface of the forward-end cover. These openings

are aligned with openings in the base of the turbocharger bracket, or with the turbocharger feet directly. Mating connections are sealed by O-rings.

Water is discharged from the turbocharger at openings near the top on its exhaust gas inlet side. These openings are connected, in turn, to the discharge pipe from the left intercooler.

The water outlet header is centrally located lengthwise over the engine, with its discharge opening connected to a junction box at the top of the right intercooler. Branch pipes welded into the header are connected to individual cylinders by compression pipe fittings. Water flowing from the intercoolers, turbocharger, and water discharge header combines at the junction box and is conducted to the fluid-amplifier flow-control valve.

The fluid-amplifier flow-control valve regulates the temperature of the system by routing the water flow from the engine as follows:

1. Directly to the water storage tank — when minimum engine cooling is required
2. To the left-bank radiator sections — when partial cooling is required
3. To all radiator sections — when full engine cooling is required.

Water cooled in the radiator is then returned to the storage tank. For minimum cooling, the flow of water to the radiator is cut off by the flow-control valve, and the water left in the radiator sections and piping is quickly drained to the storage tank by gravity flow.

FLUID AMPLIFIER

The hot coolant leaves the diesel engine, Fig. X-3, and enters the inlet port of the fluid-amplifier flow-control valve. Inside the valve housing the coolant divides into three paths; a small quantity called the control fluid passes into the thermostatic pilot valve; the main flow of coolant divides into two parallel systems.

A small portion of the coolant (the control fluid) is sensed by a thermostat in the thermostatic pilot valve. The thermostatic pilot valve controls the flow of the control fluid, which in turn, thru transverse jets and fluidic action, diverts the main flow of coolant to the tank and/or radiators. The control of the large, main flow of coolant by a small, control flow, or the amplification of the small, control flow, gives the term "fluid amplifier."

The paths of the two parallel flow systems, depending on the coolant temperature and the thermostatic pilot valve are:

1. Thru the inboard (No. 1) proportional diverting valve and pilot valve, then to the tank and/or left-bank radiators.
2. Thru the outboard (No. 2) proportional diverting valve and pilot valve, then to the tank and/or right-bank radiators.

FILLING AND DRAINING

Filling

Detailed instructions for filling the water tank are mounted on the water tank.

Draining

To completely drain the system, open Valve A and remove pump drain plug, Fig. X-4 (Item 6).

EQUIPMENT AND ENGINE AIR SYSTEMS

EQUIPMENT AIR SYSTEM

Air, Fig. X-5, enters the equipment blower compartment (forward of the engine compartment on six-axle locomotives) thru V-screens on both sides of the locomotive. The blower forces this air into the main air duct, which extends almost the full length of the locomotive and is formed by the two main sills, the top platform deck and bottom plates that join the bottom portions of the two main sills.

NOTE: *The four-axle locomotive has the blower in the rear of the locomotive.*

Pressurized air flows both forward and to the rear of the blower inside the main air duct. This air flows thru plastic air cleaners located in the duct, then to the traction motors, alternator (or traction generator), auxiliary generators, control compartment, rectifier panel, operating cab and to extended range dynamic-braking compartment (if used).

The discharge air from the alternator pressurizes the engine cab, and thereby excludes outside dirty air from this area. Some of the pressurized engine cab air, escaping around the outside of the exhaust stack, helps to direct the

exhaust gases up and away from the locomotive. The balance of the engine cab air passes thru the air-compressor drive shaft tunnel to the air-compressor intake filters.

Each air cleaner is comprised of 54 individual tubes. Each tube acts as a miniature, cyclonic dirt separator. Incoming air enters the vanes in the tubes, causing the air to swirl. Dirt particles, being heavy, go to the outside and eventually leave the far end of the outer tube. The cleaned air swirling in the central portion is discharged out of the cleaner. The bleed air carries the dirt out of the cleaner.

Openings at the bottom of each panel permit the separated dirt and bleed air to escape. It is continuously discharged from the locomotive through outlets beneath the underframe.

Test results show that most dirt particles eight microns or larger, are removed by this cleaner. (A micron is one-millionth of a meter or approximately 1/25,000 of an in.)

ENGINE AIR SYSTEM

The engine air-cleaner system is located between the engine cab and radiator cab. Ambient air enters the locomotive through a screened air inlet (which contains three plastic air cleaners) located just above the platform walkway on each side of the locomotive. The cleaned air is collected in the cleaned air plenum and is delivered up through the secondary paper air filters to the inlet of the turbocharger.

Dirty bleed air is discharged out of two holes on the end of each primary cleaner into an air duct. The bleed air then is discharged out the stack, utilizing an exhaust stack-aspirator. A check valve prevents engine exhaust gases from entering the cleaned-air system through the bleed-air duct.

Two safety or protective devices insure that an adequate supply of air is delivered to the engine for combustion. These devices are:

1. A service indicator, which indicates when the air cleaner system needs servicing.
2. A pressure switch that returns the engine to idle, actuates the trainline alarm, and illuminates the ENGINE AIR FILTER light on the engine control panel. This prevents diesel engine operation with plugged air filters.

FIG. X-5, E-15055B

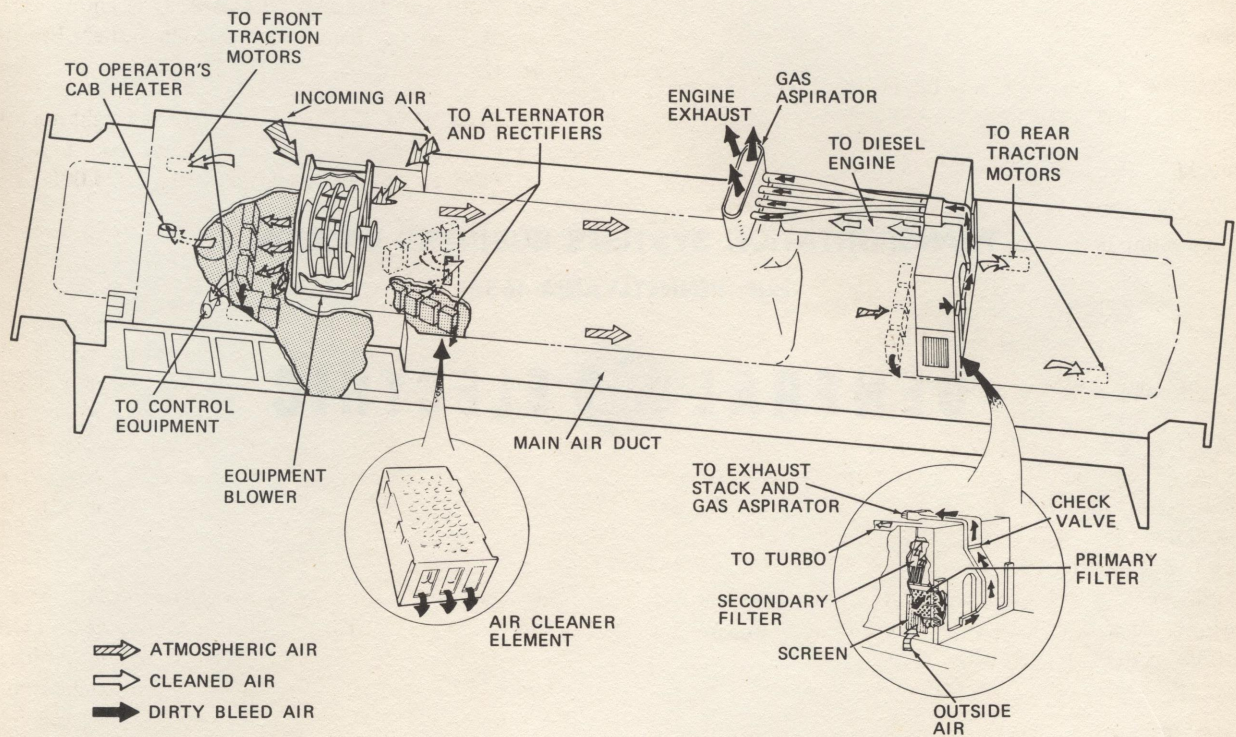


FIG. X-5. EQUIPMENT AND ENGINE AIR SYSTEMS (SIX-AXLE LOCOMOTIVE).